REDUCED IGNITION PROPENSITY SMOKING ARTICLE WITH A POLYSACCHARIDE TREATED WRAPPER

Background of the Invention

The present invention relates generally to a wrapper for a smoking article to create a reduced ignition propensity (IP) smoking article and, more particularly, to a smoking article having the ability to freeburn in a static state and reduced IP. Under some circumstances cigarettes may ignite fire-prone substrates if the article is laid or accidentally contacts the substrate. Therefore, a cigarette prepared from a wrapper, which diminishes the ability of the article to ignite a substrate, may have the desirable effect of reducing cigarette-initiated fires. Furthermore, a wrapper that concurrently confers on the cigarette the ability to freeburn in a static state and reduced IP character allows a beneficial reduction in the tendency of the article to ignite fire-prone substrates while maintaining consumer acceptability.

Cigarette manufacturers have struggled to create a cigarette that has reduced IP and consumer acceptable attributes particularly wrapper appearance and the ability to freeburn in the static state. Technologies that appear to provide such cigarettes are described in the patent literature. Cigarettes claiming to possess reduced IP are commercially available.

A factor that manufacturers consider in preparing a smoking article having reduced IP is whether currently used processes and equipment will remain substantially unchanged. A method for preparing a reduced IP paper involves the addition of elaborate equipment on a conventional papermaking machine. A water-based suspension, such as cellulose fibers or particles in water, is sprayed from angular moving nozzles moving at an angle to a continuously forming moist web. This approach involves the coordinated angular movement of the spray nozzle and the about 400 feet per minute moving web to create spaced apart bands transverse to the web. The above-mentioned technology suffers from a number of deficiencies which limits consumer acceptability, IP reduction, and ease of manufacture. The technology requires expensive add-on equipment including a spray nozzle system and associated slurry distribution system, pressure regulating system, and a means for carefully synchronizing the angular material distribution system with the underlying papermaking machine.

The reduced consumer acceptable properties of the prepared cigarettes are due to factors including reduced ability of the cigarette to freeburn in the static state, poor ash appearance, and variable taste profile.

The poor IP reduction performance achieved by cigarettes prepared with wrappers made using this technology is believed to be caused by a number of factors including difficulty in depositing an even layer of the permeability reducing slurry, low efficiency of the slurry to reduce the permeability of the underlying web, and poor reproducibility caused by fanning out of the sprayed material.

One commercial product claiming to possess reduced IP is characterized by a tendency to extinguish when left burning in the static state, that is reduced freeburn. The article displays an undesirable taste when relit after being extinguished. Thus, although the cigarette may possess the reduced IP, the reduced freeburn property decreases consumer acceptability of the article.

Other factors affecting consumer acceptability are product appearance, including pleasing and consistent wrapper appearance and ash character. Moreover, it is important that the construction of the smoking article exhibit a reasonable shelf life while maintaining reduced IP.

Thus, there remains a need for a new and improved wrapper and smoking article having reduced IP and sufficient free burn. Also, there remains a need for a new and improved method for making a wrapper that can be used to create a smoking article having reduced IP and sufficient freeburn.

Summary of the Invention

The present invention is directed to a smoking article having reduced IP. The smoking article includes a tobacco column, a wrapper surrounding the tobacco column and, optionally, a filter element. The wrapper has a base permeability, an untreated area and a least one discrete area treated with a composition to reduce the base permeability. The discretely treated area interacts with the coal of a burning tobacco firecone as it advances to self-extinguish the smoking article if the smoking article is left on a surface and causes the cigarette not to ignite the surface.

The tendency of a cigarette to self-extinguish or not ignite surfaces can be measured by the use of IP tests such as those published by the Consumer Products Safety Commission and developed by the National Institute of Standards and Technology

(NIST) or the American Society of Testing and Materials (ASTM). See Ohlemiller, T. J. et al., “Test Methods for Quantifying the Propensity of Cigarettes to Ignite Soft Furnishings. Volume 2.,” NIST SP 851; Volume 2; 166 pages [Also includes: Cigarette Extinction Test Method, see pp. 153-160] August 1993 available from: U.S. Consumer Product Safety Commission, Washington, DC 20207 as order number: PB94-108644 the subject matter of which is herein incorporated by reference. One NIST IP test, the “cotton duck test”, involves placing a smoldering cigarette on a test assembly composed of a cellulosic fabric over a foam block. Variations of the test use fabrics of various weights and polyethylene sheet backing. A test failure occurs when the fabric ignites. Another NIST IP test, the “filter paper test”, involves placing a smoldering cigarette on a test assembly composed of layered filter paper sheets. Various forms of the test use 3, 10, and 15 layered filter paper sheets. A successful test result occurs when the cigarette self extinguishes before the whole tobacco column is consumed.

The composition of the treated area includes a permeability reducing substance. Optionally, other substances in the treated area may include one or more of a filler, a burn rate retarding substance, a burn rate accelerating substance and a flavor enhancing substance.

In a wrapper making process, the applied amount of the permeability reducing substance is such as to give the desired freeburn character and IP reduction to a finished article made from the wrapper. The quantity and the concentration of the applied composition will depend on factors including the absorbency of the web, polymer properties of the permeability reducing substance, web moisture content, and the operating conditions of the application equipment.

The permeability reducing substance may be a pore filling substance, a film forming substance or combination thereof. The permeability reducing substance may be a polymer and, preferably, a polysaccharide. Among the contemplated polysaccharides is cellulose, including cellulose from any source, including cotton linters, wood, paper, vegetable fiber, bacterial cellulose, regenerated cellulose, amorphous cellulose, and crystalline cellulose. The cellulose may be dispersible in a solvent mixture and, preferably, is soluble. Other contemplated polysaccharides include starch, including various mixtures of amylose, amylopectin and dextrin, chitosan, chitosan derivatives, chitin, chitin derivatives, alginate, alginate derivatives and combinations thereof. The polysaccharides are preferably non-derivatized.

In one embodiment, the discretely treated area is a circumferential band about the body of the article. The band has a sufficient width so as to deprive the coal of the burning tobacco firecone of oxygen from behind a char line of the wrapper when the smoking article is placed on a surface. That may be achieved by a band width typically of at least about 3 millimeters.

In an alternative embodiment, the discretely treated area includes at least two bands spaced sufficiently to reduce the IP of the smoking article. In this case, the two bands preferably have a center-to-center spacing of between about 10 millimeters to about 30 millimeters. The two bands may have a width of about 3 millimeters to about 10 millimeters. A center-to-center spacing is preferably about 25 millimeters.

The discretely treated area preferably has a thickness and properties so a bobbin of the wrapper is useable in a commercially available smoking article manufacturing machine. Also, the discretely treated area is preferably visually substantially the same as the untreated area.

Still another aspect of the present invention is to provide a population of smoking articles having a reduced IP. Each smoking article within the population includes a tobacco column, wrapper surrounding said tobacco column so that the smoking article includes an ignition end and a distal end, and at least one banded region, preferably at least two spaced apart banded regions, between the ignition end and the distal end having a combustion characteristic substantially different from that of a non-banded, untreated, region. A distance from the ignition end to the at least one of the banded region of each smoking article may be one of sequentially related, random, or quasi-random within the population. Examples of the population include a package of smoking articles and a grab sample of smoking articles.

In an embodiment, the distance from the ignition end to the at least one of the banded region of each smoking article in the population is at least one of sequentially related, random, and quasi-random.

In a preferred embodiment, the IP of the selected population is between about 50 and about 100 percent for the population.

The invention also provides a method of making a wrapper, of making a smoking article having reduced IP, and a composition for application to a paper to make a wrapper and a smoking article.

Brief Description of the Drawings

The invention will be better understood after a reading of the following description of the preferred embodiment when considered with the drawings in which:

FIGURE 1 is a perspective view of a smoking article according an embodiment of the present invention;

FIGURE 2 is an exploded view of the smoking article of Figure 1;

FIGURE 3 is a perspective view of a bobbin of wrapper that may be used to make the smoking article of Figure 1;

FIGURE 4 is a plan view of a wrapper as might be accumulated in a bobbin as shown in Figure 3;

FIGURE 5A is an example of a population of smoking articles having a substantially random distance from the ignition end to the at least one of the banded regions of each smoking article within the population according an embodiment of the present invention;

FIGURE 5B is an example of a population of smoking articles having a quasi random distance from the ignition end to the at least one of the banded regions of each smoking article within the population according an embodiment of the present invention;

FIGURE 5C is an example of a population of smoking articles having a sequentially related distance from the ignition end to the at least one of the banded regions of each smoking article within the population according an embodiment of the present invention;

FIGURE 6 is a schematic of a package of smoking articles of any of Figure 1, Figure 5A, Figure 5B, and Figure 5C; and

FIGURE 7 shows ignition propensity for populations of cigarettes of the present invention compared to the prior art.

Description of the Preferred Embodiments

Referring now to the drawings in general and Figure 1 in particular, it will be understood that the illustrations are for the purpose of describing a preferred embodiment of the invention and are not intended to limit the invention thereto. As best seen in Figure 1, a smoking article 10 includes a tobacco column 12 surrounded by a wrapper 14. The smoking article 10 may, as an option, include a filter element 16 adjacent to the tobacco column 12 surrounded by the wrapper 14.

Figure 2 shows an exploded view of the smoking article 10 of Figure 1 including certain aspects relating to the wrapper 14, which is a modified cigarette paper. In particular, wrapper 14 includes untreated areas 20 alternating with treated areas 22. Discrete areas 22 may include a combination of substances that interact with the wrapper 14 to create the reduced IP smoking article 10. At least one of the substances in treated area 22 includes a permeability reducing substance. Optionally, other substances in the treated area may include one or more of a filler, a burn rate retarding substance, a burn rate accelerating substance and a flavor enhancing substance. These substances interact with each other and the wrapper paper 14 to create a wrapper that may be used to manufacture reduced IP smoking article 10.

The permeability reducing substance may be a polymer. The polymer may be any one of a natural polymer, a derivative of a natural polymer, a synthetic polymer, and a combination of any of the preceding. Applicants have found that polysaccharides are suitable as permeability reducing substances. The polysaccharides may be at least one of a starch, cellulose, chitosan, chitin, alginate, or a combination of any of the preceding. Preferably, the polysaccharides are non-derivatized. Any polysaccharide that suitably reduces the permeability of the wrapper would be appropriate for use as the permeability reducing substance.

Applicants believe that cellulose and starch would act particularly well as permeability reducing substances. Applicants have found that cellulose works particularly well as the permeability reducing substance when applied using a solvent mixture initially comprising an organic solvent component and at least one ingredient that as part of the solvent mixture is a self-association disruptor for cellulose. Applicants believe that polysaccharides such as starch, cellulose, chitosan, chitin, alginate, and a combination of any of the preceding may also work well as the permeability reducing substance when applied using a non-derivatizing solvent mixture initially comprising a solvent component and at least one ingredient that as part of the solvent mixture is a self-association disruptor.

The solvent component may include at least one of dimethylacetamide (DMAC) and N-methylpyrrolidone (NMP). Synonyms for dimethylacetamide (DMAC) include N,N-dimethylacetamide; acetic acid, dimethylamide; dimethyl acetamide; acetdimethylamide; dimethylamide acetate; and acetyldimethylamine. Synonyms for N-methylpyrrolidone (NMP) include methylpyrrolidone; 1-methyl-5-pyrrolidinone; N-

methyl-2-pyrrolidone; 1-methyl-2-pyrrolidone; 1-methylpyrrolidinone; N-methylpyrrolidinone and N-methyl-2-pyrrolidinone.

The ingredient is a self-association disruptor such as a salt, preferably one containing lithium, and more preferably, lithium chloride.

An alternative solvent mixture for cellulose may initially comprise a 4-methylmorpholine N-oxide as the solvent component and water as the at least one ingredient that is a self-association disruptor. Synonyms for 4-methylmorpholine N-oxide include 4-methylmorpholine N-oxide monohydrate; NMO monohydrate; and N-methyl morpholine-N-oxide.

A preferred system for applying polysaccharides to a wrapper according to the present invention includes a polysaccharide in dimethylacetamide (DMAC) including lithium chloride (LiCl) substantially as described in: U.S. Patent No. 4,302,252 entitled "Solvent System for Cellulose" issued November 24, 1981 in the name of Turbak et al.; U.S. Patent No. 4,352,770 entitled "Process For Forming Shaped Cellulosic Product" issued October 5, 1982 in the name of Turbak et al.; Maria Terbojevich et al. "Mesophase Formation and Chain Rigidity in Cellulose and Derivatives. 3. Aggregation of Cellulose in N,N-Dimethylacetamide-Lithium Cloride," ***Macromolecules*** 1985, 18, 640-646; Charles L. McCormick et al., "Solution Studies of Cellulose in Lithium Chloride and N,N-Dimethylacetamide," ***Macromolecules*** 1985, 18, 2394-2401; K.J. Edgar et al., "Synthesis and Properties of Cellulose Acetoacetates," ***Macromolecules*** 1995, 28, 4122-4128; Makoto Hasegawa et al., "Size-exclusion Chromatography of Cellulose and Chitin Using Lithium Chloride- N,N-Dimethylacetamide as a Mobile Phase," ***Journal of Chromatography*** 1993, 635, 334-337; Lev Bromberg, "Salt-Mediated Miscibility of Proteins and Polymers," ***Journal of Physical Chemistry*** 1994, 98, 10628-10633; and Thomas J. Heinze, "New Polymers by Unconventional Functionalization of Polyglucans," Friedrich Schiller University of Jena, Humboldstrasse 10, D-07743 Jena, Germany, publication date unknown (http://www.chem-eng.nwu.edu/us-germany/abstracts/heinze_abs.pdf) copies of which are filed with this application and each being hereby incorporated by reference in its entirety.

Without wishing to be bound by any scientific theory and explanation, applicants believe that a permeability reducing substance may interact with the wrapper in a number of ways. In one, a permeability reducing substance may form a film on the wrapper 14 to reduce permeability by blocking pores in the wrapper 14. That is, when the permeability

reducing substance is applied to the wrapper 14, a film is created that acts as a barrier to block the movement of gas through pores in the discretely treated area 22.

Alternatively, a permeability reducing substance may act to fill pores and thereby reduce the porosity of the wrapper 14. In this way, a discretely treated area 22 possesses porosity or gas permeability less than that of the untreated area 20 of the wrapper 14.

As a further alternative, a permeability reducing substance may both form a film on the wrapper 14 and act to fill pores in the wrapper 14 so that a discretely treated area 22 possesses a porosity or gas permeability less than that of the untreated area 20 of the wrapper 14.

A manufacturing of discretely treated areas 22 may be made by applying compositions that are applicable to the wrapper 14 when the wrapper 14 might be in a wet or dry state or a semi-wet state. Those skilled in the art will appreciate that the quantity and the concentration of the applied composition will depend on factors including the absorbency of the web, polymer properties of the permeability reducing substance, web moisture content, and the operating conditions of the application equipment. Moreover, those skilled in the art will appreciate that the composition may be applied by a number of known methods including spraying, stenciling, offset, letterpress, flexographic, gravure printing, and the like including both multiple-pass and single-pass processes.

Preferably, the composition for affecting the discretely treated areas may be applied on one side of the base paper such that the formed band 22 faces the tobacco-side 12 after making article 10 from the banded paper. Alternatively, the composition may be applied on both sides of the paper or applied such that the formed band 22 faces the outside or consumer-side after making article 10 from the banded paper.

Manufacturing of reduced IP smoking articles is preferably accomplished using a reel, or bobbin, length of wrapper 14 with discretely treated areas 22 and untreated areas 20. Using a bobbin of banded paper in a cigarette-making machine will provide a population of banded smoking articles having a reduced IP. That is, each smoking article within the population will include a tobacco column, wrapper surrounding said tobacco column so that the smoking article includes an ignition end and a distal end, and at least one banded region, preferably at least two spaced apart banded regions, between the ignition end and the distal end whereby the distance from the ignition end to the at least one of the banded region of each smoking article is sequentially related, random, or quasi-random within the population.

Applicants believe that the sequentially related, random, or quasi-random band position would have the benefit of allowing the cigarette population as a whole to have fewer tendencies to ignite fire-prone substrates. Overall, IP tests incorporate a fixed burn-down distance in which the article is burned before being placed on the test substrate. In real-world ignition scenarios the article may burn down to any distance with respect to the ignition end of the article before contacting a substrate. Therefore, a sequentially related, random, or quasi-random band position will increase the probability that any individual member of the banded article population may prevent ignition of a prone substrate when the article is burned down to a random distance before substrate contact. Alternatively, bands may be registered at a fixed distance with respect to the ignition end of article 10. The preferred embodiment of this invention is for the manufacture of reduced IP articles having a sequentially related, random, or quasi-random band position with respect to the ignition end of article 10.

In each of the examples, sample cigarettes were prepared by "hand banding" whereby a circumferential ring of material was applied around the body of smoking article, by hand, using an aluminum printing plate. The aluminum printing plate was fashioned from a slab of aluminum metal with a straight channel, about 7 millimeters wide and about 30 millimeters long, milled below the surface of the slab. A banding composition was used to fill the channel of the printing plate. The smoking article was then rolled, by hand, across the composition-filled channel such that a circumferential band was formed about the body of the smoking article. Therefore, the about 7 millimeter wide band was printed on one side of the wrapper such that band 22 was on the outside or consumer-side of article 10. Hand banded cigarettes are characterized as having the applied band registered at a fixed position with respect to the ignition end of the article.

In each of the examples, a conventional flax pulp cigarette paper was used as a wrapper for the smoking articles. The cigarette paper had the following properties: 18 CU (CORESTA units, $cm^3/min/cm^2$ at 1 kPa measuring pressure) permeability, 30 weight percent calcium carbonate filler, 0.85 weight percent citrate salt, and 25.5 g/m^2 basis weight.

Example 1 Cellulose/ DMAC/lithium chloride compositions were used to make circumferential bands, about 7 millimeters wide, around the body of non-banded smoking

articles. The circumferential band was applied by hand and positioned about 15 millimeters from the ignition end of the smoking article.

The non-banded smoking article was made using a conventional paper wrapper, an about 72 millimeter tobacco column length, an about 25 millimeter cellulose acetate non-air diluted filter section, and a cigarette tobacco blend. Cigarettes were made on a conventional cigarette-making machine.

Composition 1-1 was prepared by soaking about 20.60 grams cellulose (Sigma-Aldrich, St. Louis, MO; Catalog #C-6663) in water for 2 hours. The water was removed by filtration and then by soaking the moist cellulose in about 150 milliliters DMAC. After about 3 hours, the solvent was again removed by filtration. Then the solvent-moist cellulose was added to about 400 milliliters of DMAC containing about 40.4 grams lithium chloride. After stirring for about two days a colorless, visually-homogeneous, composition was produced.

Composition 1-2 was prepared by mixing about 7.4002 grams of composition 1-1 with about 7.3 grams DMAC. Composition 1-3 was prepared by mixing about 1.6 grams of composition 1-1 with about 9.3 grams DMAC. Composition 1-4 was prepared by mixing about 4.9 grams of composition 1-1 with about 22.1 grams DMAC. Composition 1-5 was prepared by dissolving lithium chloride in DMAC such that lithium chloride concentration was about 10 weight percent concentration.

Applicants found that the appearance of the cellulose band, formed by the application of cellulose/DMAC/lithium chloride, was nearly indistinguishable from the untreated areas of the wrapper. A band composed of lithium chloride alone (Composition 1-5, Table 1) was found to be ineffective for IP reduction.

Applicants also found that the char line on the wrapper, as the banded article was smoked, displayed an increase in width as the firecone traversed the cellulose/DMAC/lithium chloride banded area. Applicants attribute the increase in char line width to the presence of lithium chloride in the treated area. Therefore, the preferable composition of the band is to contain the minimum quantity of lithium chloride.

The IP data in Table 1 demonstrates that about 104 micrograms (μg) dry cellulose, applied as cellulose/DMAC/lithium chloride, forms a substantially 100% effective, IP reducing, about 7 millimeter wide band.

Table 1. IP Results For Cellulose/DMAC/Lithium Chloride Banded Cigarettes.

Composition	IP Pass (%) **	Dry band weight (µg) *
1-5	0.0	0
1-3	0.0	16
1-4	0.0	22
1-3	0.0	25
1-3	0.0	43
1-1	60.0	73
1-2	87.5	90
1-1	100.0	104
1-1	100.0	136

* Cellulose component; Average weight on 8 treated cigarettes
** NIST (#6) cotton duck IP test; 8 cigarettes studied

Example 2 Cellulose/ DMAC/lithium chloride composition 1-1 (Example 1) was used to make circumferential bands, about 10 millimeters wide, around the body of non-banded smoking articles. The circumferential band was applied by hand-banding as previously described except the channel of the printing plate was about 10 millimeters wide. The band was positioned about 15 millimeters from the ignition end of the smoking article.

The non-banded smoking article was made using a conventional paper wrapper, an about 72 millimeter tobacco column length, an about 25 millimeter cellulose acetate non-air diluted filter section, and a cigarette tobacco blend. Cigarettes were made on a conventional cigarette-making machine.

Applicants found that the appearance of the cellulose band, formed by the application of cellulose/DMAC/lithium chloride, was nearly indistinguishable from the untreated areas of the wrapper.

The IP data in Table 2 demonstrates that about 110 micrograms (µg) dry cellulose, applied as cellulose/DMAC/lithium chloride, forms a substantially 100% effective, IP reducing, about 10 millimeter wide band.

Table 2. IP Results For Cellulose/DMAC/Lithium Chloride Banded Cigarettes.

Composition	IP Pass (%) **	Dry band weight (µg) *
1-1	100.0	110
1-1	100.0	290

* Cellulose component; Average weight on 8 treated cigarettes
** NIST (#6) cotton duck IP test; 8 cigarettes studied

Example 3 Cellulose/ DMAC/lithium chloride composition was used to make circumferential bands, about 7 millimeters wide, around the body of non-banded smoking articles. The circumferential band was applied by hand and positioned about 15 millimeters from the ignition end of the smoking article.

The non-banded smoking article was made using a conventional paper wrapper, an about 72 millimeter tobacco column length, an about 25 millimeter cellulose acetate non-air diluted filter section, and a cigarette tobacco blend. Cigarettes were made on a conventional cigarette-making machine.

Composition 3-1 was prepared by dissolving about 39.7 grams lithium chloride in about 500 milliliters DMAC using stirring and heating. After the lithium chloride dissolved, about 27.5 grams cellulose (Sigma-Aldrich, St. Louis, MO; Catalog #C-6663) was added to the DMAC/lithium chloride solution. The resulting mixture was heated at about 135°C for about 1 hour, with mechanical stirring. Then the mixture was allowed to cool and stand for about 5 days at room temperature, after which a visually homogeneous composition was produced.

Eight smoking articles were banded with composition 3-1 such that the dry weight of cellulose in the treated region was about 230 micrograms. IP of the treated articles was measured by the NIST #6 cotton duck IP test and gave a 100% pass rate.

Example 4 Cellulose/NMP/lithium chloride composition was used to make circumferential bands, about 7 millimeters wide, around the body of non-banded smoking articles. The circumferential band was applied by hand and positioned about 20 millimeters from the ignition end of the smoking article.

The non-banded smoking article was made using a conventional paper wrapper, an about 63 millimeter tobacco column length, an about 21 millimeter cellulose acetate non-air diluted filter section, and a cigarette tobacco blend. Cigarettes were made on a conventional cigarette-making machine.

The cellulose/NMP/lithium chloride was prepared from about 105.5 grams microcrystalline cellulose (Aldrich, Milwaukee, WI; Catalog #31,069-7) added to about 700 milliliters NMP. The mixture was stirred and heated to about 170°C then allowed to cool to about 110°C over 15 minutes. Then about 52.4 grams lithium chloride was added and the mixture was held at about 110°C until the lithium chloride dissolved. The

mixture was allowed to gradually cool to room temperature. After stirring overnight, a viscous and visually-homogeneous composition was produced. The cellulose/NMP/lithium chloride composition, about 1.44 grams, was diluted with about 3 grams NMP to give composition 4-1.

Eight smoking articles were banded with composition 4-1 such that the dry weight of cellulose in the treated region was about 160 micrograms. IP of the treated articles was measured by the NIST 10-sheet filter paper IP test and gave substantially a 100% pass rate.

Eight smoking articles were banded with composition 4-1 such that the dry weight of cellulose in the treated region was about 116 micrograms. IP of the treated articles was measured by the NIST 10-sheet filter paper IP test and gave substantially a 100% pass rate.

Eight smoking articles were banded with composition 4-1 such that the dry weight of cellulose in the treated region was about 112 micrograms. Freeburn of the treated articles was measured by igniting a cigarette and placing the smoldering articles horizontally in a holder. The articles were allowed to statically smolder without the column or ember contacting a surface. A positive freeburn result occurred when the cigarette was consumed to the filter element. All 8 treated articles were found to freeburn.

Example 5 Starch/NMP composition was used to make circumferential bands, about 7 millimeters wide, around the body of non-banded smoking articles. The circumferential band was applied by hand and positioned about 20 millimeters from the ignition end of the smoking article.

The non-banded smoking article was made using a conventional paper wrapper, an about 63 millimeter tobacco column length, an about 21 millimeter cellulose acetate non-air diluted filter section, and a cigarette tobacco blend. Cigarettes were made on a conventional cigarette-making machine.

The starch/NMP composition was prepared from about 16.9 grams Flokote-64® starch (National Starch, Berkeley, CA) mixed with about 100 milliliters NMP. The mixture was stirred and heated to about 110°C then allowed to cool to room temperature over about 1 hour. After cooling, a viscous and visually-homogeneous composition was

produced. The starch/NMP composition, about 5 grams, was then diluted with about 5.1 grams NMP to give composition 5-1.

Eight smoking articles were banded with composition 5-1 such that the dry weight of starch in the treated region was about 1.4 milligrams. Composition 5-1 was applied on the articles as a double layer band that is, a second band was overprinted a previously applied, and dried, layer of composition 5-1. IP of the treated articles was measured by the NIST 10-sheet filter paper IP test and gave a 100% pass rate.

<u>Example 6</u> β-Cyclodextrin/DMAC/lithium chloride composition was used to make circumferential bands, about 7 millimeters wide, around the body of non-banded smoking articles. The circumferential band was applied by hand and positioned about 15 millimeters from the ignition end of the smoking article.

The non-banded smoking article was made using a conventional paper wrapper, an about 72 millimeter tobacco column length, an about 25 millimeter cellulose acetate non-air diluted filter section, and a cigarette tobacco blend. Cigarettes were made on a conventional cigarette-making machine.

Composition 6-1 was prepared from about 5.3 grams β-cyclodextrin (Fluka Chemical, Milwaukee, WI; Catalog #28707) added to about 10 milliliters DMAC and about 4 milliliters DMAC containing about 9.8 weight percent lithium chloride. β-Cyclodextrin was dissolved by heating and stirring the mixture at about 100°C for about one hour and then allowing the mixture to stand overnight. Composition 6-2 was prepared by mixing about 1 milliliter of composition 6-1 with about 5 milliliters DMAC.

Eight smoking articles were banded with composition 6-1 such that the dry weight of β-cyclodextrin in the treated region was about 2.3 milligrams. IP of the treated articles was measured by the NIST #6 cotton duck IP test and gave substantially a 100% pass rate.

Eight smoking articles were banded with composition 6-2 such that the dry weight of β-cyclodextrin in the treated region was about 440 micrograms. IP of the treated articles was measured by the NIST #6 cotton duck IP test and gave substantially a 0% pass rate.

Example 7   The effectiveness of various permeability reducing agents was compared using a conventional flax cigarette paper with the following properties: about 32 CU permeability, about 28 weight percent calcium carbonate, about 0.60 weight percent citrate salt, and about 26.0 g/m^2 basis weight.

About 20-centimeter lengths of paper were cut and permeability-reducing compositions were evenly applied in an area about 27.3 millimeters wide by about 32.5 millimeters long. After treatment, the strips were stored overnight at about 75°C and about 65% relative humidity. Permeability values for the treated area were measured with a Filtrona PM-100 permeability unit (1 kPa measuring pressure).

Composition 7-1 comprised about 16 weight percent starch (National Starch, Berkeley, CA, Item #51,6437) and about 84 weight percent water. Composition 7-1 was prepared by dispersing the starch powder in cold water and heating the mixture for about 15 minutes at about 87°C. Composition 7-2 comprised about 6.5 weight percent ethyl cellulose (Fisher Scientific, Fair Lawn, NJ; Catalog #E-152) and about 93.5 weight percent ethyl alcohol solution (95 volume percent ethyl alcohol and 5 weight percent water).

Composition 7-3 comprised about 11.9 weight percent ethyl cellulose (Fisher Scientific, Fair Lawn, NJ; Catalog #E-152) and about 88.1 weight percent isopropyl acetate. Composition 7-4 comprised about 9.7 weight percent hydroxypropyl cellulose (Aldrich, Milwaukee, WI; Catalog #43,500-7) and about 90.3 weight percent deionized water. Composition 7-5 comprised about 6.0 weight percent microcrystalline cellulose (Aldrich, Milwaukee, WI; Catalog #43,524-4; cellulose powder coated with about 15 weight percent sodium carboxymethylcellulose) and about 94.0 weight percent deionized water.

Table 3 gives permeability values for paper treated separately with cellulose/DMAC/lithium chloride, ethyl cellulose, hydroxypropyl cellulose, cellulose/water, and starch/water compositions. In all cases, application of the banding solution caused a decrease in permeability relative to untreated paper. In particular, applicants unexpectedly discovered that cellulose/DMAC/lithium chloride is a very efficient permeability reducing substance.

The mechanism by which low paper porosity may give reduced IP is not known with certainty but may be due to oxygen starvation of the firecone. When the cigarette is laid down on a substrate the low permeability of the treated area may cause a reduction of

oxygen to the fire cone and consequently cause the article to self-extinguish.

Cellulose/DMAC/lithium chloride has shown to be an unexpectedly efficient permeability reducing substance which may explain the minute quantity (as shown in Example 1 and others) that are required to give a reduced IP article. Applicants believe that other polysaccharides combined with self-association disruptor solvent systems will display efficient permeability reducing properties. Furthermore, the efficient permeability-reducing nature of cellulose/DMAC/lithium chloride (and the like) make the composition compatible with high-speed printing operations thereby allowing for the efficient manufacture of reduced permeability regions on a material such as paper.

Table 3. Permeability Values of Banded Cigarette Paper.

Banding Material	Band Weight (μg/mm^2) *	Permeability (CU)
Cellulose/DMAC/Lithium Chloride (Composition 1-1)	0.50	TLM
	0.73	TLM
	0.79	TLM
Starch (Composition 7-1)	2.51	3.6
	2.75	2.0
Ethyl Cellulose (Composition 7-2)	1.63	11.7
	1.86	4.5
	2.65	TLM
Ethyl Cellulose (Composition 7-3)	1.10	4.5
Hydroxypropyl cellulose (Composition 7-4)	2.12	14.0
Cellulose/Water (Composition 7-5)	1.38	20.2

* Dry polymer weight per unit area
TLM = Permeability value too low to measure

<u>Example 8</u> The effectiveness of various permeability reducing agents for smoking article IP reduction was compared. Compositions, as listed in Table 4, were used to make circumferential bands, about 7 millimeters wide, around the body of non-banded smoking articles. The circumferential band was applied by hand and positioned about 15 millimeters from the ignition end of the smoking article.

The non-banded smoking article was made using a conventional paper wrapper, an about 72 millimeter tobacco column length, an about 25 millimeter cellulose acetate non-air diluted filter section, and a cigarette tobacco blend. Cigarettes were made on a

conventional cigarette-making machine.

Composition 8-1 comprised a suspension of about 5.1 weight percent microcrystalline cellulose (Aldrich, Milwaukee, WI; Catalog #43,524-4; cellulose powder coated with about 15 weight percent sodium carboxymethylcellulose) and about 94.9weight percent deionized water.

Composition 8-2 comprised a suspension of about 9.10 weight percent microcrystalline cellulose (Aldrich, Milwaukee, WI; Catalog #43,524-4) and about 90.90 weight percent deionized water.

Composition 8-3 comprised about 13.6 weight percent cellulose propionate (Aldrich, Milwaukee, WI; Catalog #45,490-7), about 43.2 weight percent isopropyl alcohol, and about 43.2 weight percent 2-butanone.

Table 4. IP Results For Banded Cigarettes.

Composition	IP Pass (%) **	Dry band weight (μg) *
Cellulose/DMAC/Lithium Chloride (Composition 1-1) ***	100.0	104
Cellulose/Water (Composition 8-1)	0.0	250
Cellulose/Water (Composition 8-1)	0.0	480
Cellulose/Water (Composition 8-2)	100.0	910
Cellulose Propionate/Isopropyl Alcohol/2-Butanone (Composition 8-3)	37.5	150
Cellulose Propionate/Isopropyl Alcohol/2-Butanone (Composition 8-3)	100.0	330

* Polymer component; Average weight on 8 treated cigarettes
** NIST (#6) cotton duck IP test; 8 cigarettes studied
*** See Example 1

Table 4 and Figure 7 demonstrates that, as applied, cellulose/DMAC/lithium chloride is a very efficient material for forming a reduced IP smoking article. Cellulose when combined with a self-association disruptor solvent system is more efficient than cellulose suspended as particles in water (Composition 8-2). Furthermore, cellulose/DMAC/lithium chloride was found to be more efficient than the organic solvent soluble cellulose derivative cellulose propionate (Composition 8-3). Applicants believe

that other polysaccharides combined with self-association disruptor solvent systems will display efficient permeability reducing properties.

Figure 7 graphically illustrates that discrete areas on the smoking article wrapper formed by the application of about 0.3 micrograms per square millimeter to about 1.2 micrograms per square millimeter of substantially non-derivatized cellulose applied using lithium chloride in dimethylacetamide (DMAC) and the like may give an article with reduced IP properties. Those skilled in the art will appreciate that application of a material amount in excess of that required to give 100% effective IP reduction will also give 100% IP reduction.

Certain modifications and improvements will occur to those skilled in the art upon a reading of the foregoing description. For example, after treating the paper with a permeability reducing substance, such as cellulose/DMAC/lithium chloride and the like, the salts, e.g., lithium chloride, content may be reduced or redistributed in paper by a variety of techniques known to those skilled in the art such as application of water, and application of water in conjunction with the application of blotting or suction. Applicants believe that the reduction of the lithium chloride content of cellulose/DMAC/lithium chloride (and the like) treated paper will be useful for the manufacture of reduced IP smoking articles. It should be understood that all such modifications and improvements have been deleted herein for the sake of conciseness and readability but are properly within the scope of the following claims.